

clinical applications exemplified. Finally, future directions will be discussed.

SP-0634

Cine cone beam CT imaging with and without prior images

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Cone beam CT (CBCT) has been widely utilized for localizing daily tumor position and patient positioning in lung cancer radiotherapy. However, due to the respiratory motion during the CBCT scan, the tumor image is blurred and may introduce inaccuracy in treatment delivery. To solve this problem, and to obtain accurate daily lung tumor motion information, we have been developing cine CBCT technologies, either with or without prior images, to reconstruct a series of 3D CBCT images from a regular CBCT scan, corresponding to different breathing phases or time points during the scan. For the technology using prior images, we used 4DCT as training data. A deformable image registration is first carried out between among 4DCT images resulting in deformation vector fields (DVF). These DVFs are represented by a few eigenvectors and coefficients obtained from principal component analysis (PCA). The volumetric reconstruction from a CBCT projection is realized by optimizing the PCA coefficients such that the computed projection matches the measured CBCT projection. For the technology without prior images, we developed a novel algorithm to reconstruct a 3D image corresponding to each CBCT projection, by effectively utilizing the underlying temporal coherence, such as periodicity or repetition, in all reconstructed 3D images. Assuming each column of the matrix U represents a CBCT image to be reconstructed and the total number of columns is the same as the number of projections, the central idea of our method is that U can be approximated well by a matrix whose rank is much smaller than the number of projections in the matrix factorization form $U = LR$. The number of columns for the matrix L constrains the rank of approximation and hence implicitly imposing a temporal coherence condition among all the images in cine-CBCT. We further impose desired image properties by enforcing sparsity of the tight wavelet frame transform of L . In this matrix factorization formulation both the low rank approximation and the sparse representation in wavelet transform domain reduces the true degree of freedom of U significantly. A split Bregman method is used to solve the problem.

JOINT SYMPOSIUM: ESTRO-GEC-ESTRO: BRACHY-THERAPY - GYNAECOLOGY

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Role of image-guided adaptive brachytherapy in the treatment of cervical cancer

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The standard treatment of locally advanced cervical cancer consists of external beam radiotherapy with concomitant cisplatin followed by intracavitary brachytherapy (BT). For decades BT has most often been based on radiographs with the BT dose prescribed to point A.

In 2005 an adaptive target concept for BT based on 3D imaging was introduced by the GYN GEC-ESTRO working group addressing both the tumour extend at diagnosis - the Intermediate Risk Clinical Target Volume (IR CTV) as well as the remaining tumour at time of BT - the High Risk Clinical Target Volume (HR CTV).

With the introduction of Image Guided Adaptive BT (IGABT) it is possible to move from point A to 3D dose volume prescription in terms of dose volume histogram (DVH) parameters. Furthermore, dose optimisation can be performed with modifications of standard loading patterns leading to an individually sculpted pear-shaped isodose tailored to the target and organs (OAR) at risk at time of BT.

However, dose optimisation based on intracavitary (IC) BT applicators have limitations especially in large tumours with extensive parametrial involvement remaining at time of BT or in cases with unfavourable combination of topography between the HR CTV and the OAR. A solution is to add an interstitial (IS) component to the basic IC applicator. Studies with limited number of patients have shown that combined IC/IS BT improve the DVH parameters, but larger studies on clinical feasibility are sparse and widespread implementation of the IC/IS technique is so far limited.

At present, promising mono-institutional data on IGABT for cervical cancer with high local control rates and limited morbidity have been

published. Furthermore, several studies have established dose constraints for target as well as OAR.

In order to achieve more experience on IGABT for cervical cancer, large-scale multi-studies such as the EMBRACE-study and RETROEMBRACE-study have been initiated. During the next years, data will mature for analysis and serve as benchmark for future IGABT in cervical cancer.

The purpose of this lecture is to describe and explain the basic components behind the recommendations from the GYN GEC-ESTRO working group. Furthermore, it is aimed to review the literature on IGABT and describe outcome in terms of local control, survival and morbidity from published mono-institutional series of patients. Finally, it is aimed to describe the future directions in IGABT for cervical cancer.

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Physics aspects of treatment planning for intracavitary w/o interstitial techniques in cervical cancer

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For cervical cancer interstitial and intracavitary brachytherapy techniques are an option to treat the tumour sufficient by keeping the traditional pear-shaped isodose distribution. Improvement of target coverage and organs at risk sparing is determined by DVH parameters D90, D98 (D100) for the target and D2cc, D0.1cc for OAR. The major limitation in the optimization process is the dose to the adjacent OAR's like sigmoid, rectum and bladder. As the pear-shaped dose distribution based on the intracavitary applicator can be enlarged to a certain extend only, additional needles are useful to push the isodose lines into the needed direction (Parametrium- pelvic side wall).

The selection of the adequate application technique depends on the size and shape of the target volume at time of brachytherapy (after EBRT). With intracavitary techniques tumours which are limited to the cervix can be appropriately treated. Nevertheless, small tumours with unfavourable topographies within the pelvis (narrow anatomies with only a small distance from the tumour to the OAR bladder, rectum or sigmoid) may benefit from the use of additional needles. Over the last years "standard" intracavitary applicators have been modified in a way to allow insertion of needles through guiding holes, i.e. the "vaginal" part of the applicator (ring, ovoid or mould) serves as and interstitial template which is attached to the cervix. Other techniques use vaginal cylinders including oblique guiding holes or templates like the MUPIT or Syed. For vaginal cancer intravaginal templates exist. In interstitial treatment planning, traditionally, the Paris System rules are kept in mind. Different tools like inverse planning, graphical drag-and-drop of isodose lines and other optimization techniques are available but should be handled with caution. The final dose distribution including high dose volumes should always be checked before irradiation. In situation of complex tumour configurations pre-planning of the application technique with 3D imaging increases the quality of the implant and of the final treatment plan.

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The role of the radiation technologist in the Brachytherapy (BT) Service at the Gustave Roussy Institute

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The BT Service, in terms of material, is composed of five pulsed dose rate (PDR) and one high dose rate (HDR) afterloaders. Interstitial, endocavitary and endoluminal BT are performed depending on the type and tumor localizations. The team consists of physicians, residents, medical physicists and radiation therapy technologists (RTTs). The presentation purpose is to describe the role and the work of an RTT in the treatment of patients with cervix cancers in our institute.

Role of RTT:

RTT plays a major role in a BT service. Essential for the team cohesion, she is working at the interface of the radiation oncologist, medical physicist, and patient. Present in all steps of the treatment, she participates to the consultation, preparation, implantation, dosimetry and treatment compliance. In order to improve the overall treatment conditions, a pre-therapeutic consultation is systematically performed by the RTT. The aim is to answer questions about hospitalization, radioactivity, management of pain and treatment itself. A picture book describing the different steps of the treatment was designed by RTT. This helps and allows a better understanding for patients.

The technique used in our institute for the cervix BT consists of the vaginal mould technique. For each patient, a customized vaginal mould is created from a vaginal impression. The mould applicator